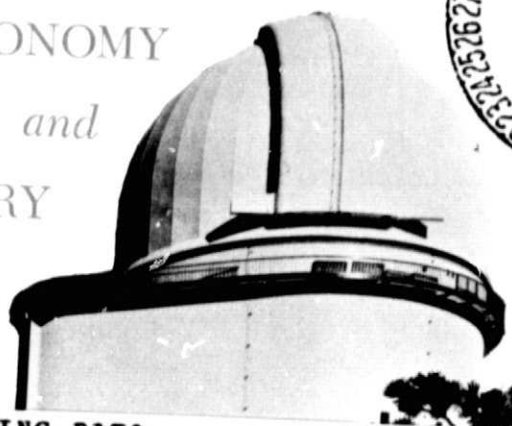
THE UNIVERSITY OF TEXAS AT AUSTIN

DEPARTMENT OF ASTRONOMY

and

McDONALD OBSERVATORY

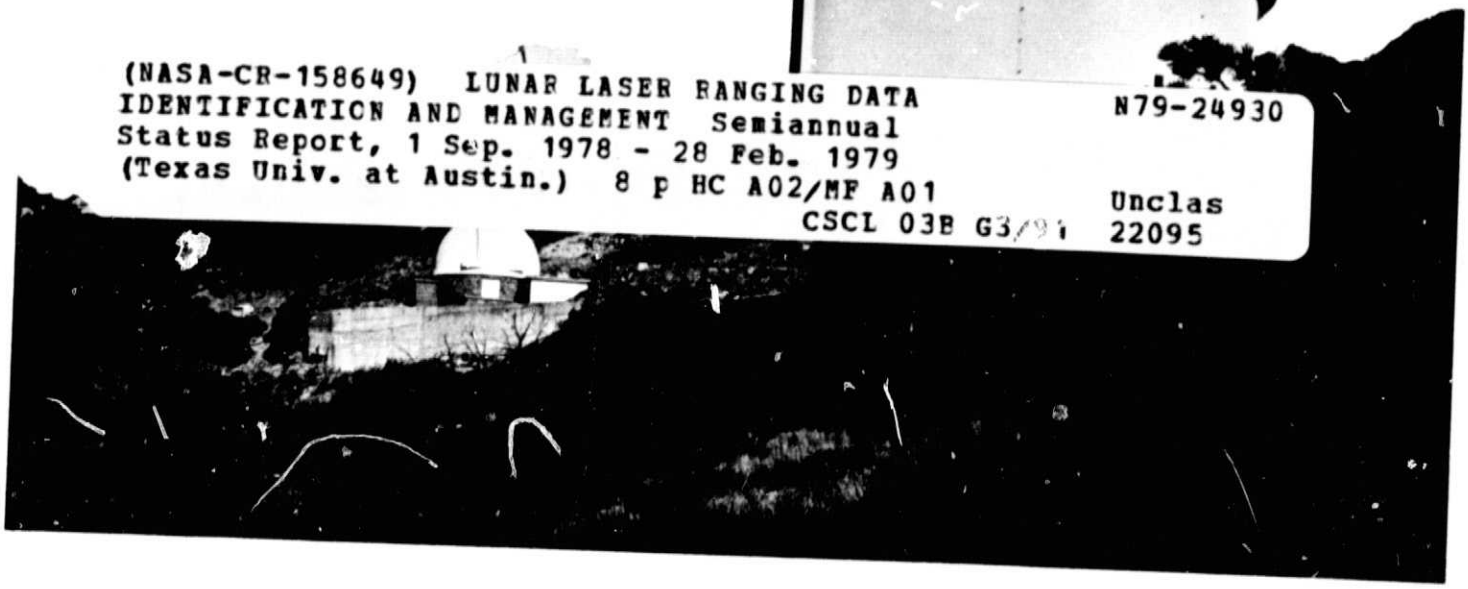
Austin, Texas 78712



(NASA-CR-158649) LUNAR LASER RANGING DATA IDENTIFICATION AND MANAGEMENT Semiannual Status Report, 1 Sep. 1978 - 28 Feb. 1979 (Texas Univ. at Austin.) 8 p HC A02/MF A01 CSCL 03B G3/91

N79-24930

Unclas 22095



Seventh Semi-Annual Status Report

NASA Grant NSG 7162

Lunar Laser Ranging Data Identification and Management

1978 September 1 through 1979 February 28

University of Texas at Austin
Department of Astronomy
Austin, Texas 78712

1979 March

Peter J. Shelus
Project Director

Abstract

This report covers activity under the subject grant during the first half of fiscal year 1979 at the University of Texas at Austin. Raw lunar laser ranging data submitted by McDonald Observatory, Fort Davis, Texas and by the Australian Division of National Mapping at Orroral Valley, Australia have been processed (no data transmissions were received from the Haleakala station during this report period). This processing includes the filtering of signal events from noise photons, normal point formation, data archive management, and data distribution. System-wide program maintenance and up-grade has been carried out wherever and whenever necessary. Participation with the Bureau Internationale de l'Heure continues as we transmit lunar laser ranging data from Austin to Paris for the extraction of earth rotation information during the EROLD campaign.

I. Data Identification and Management

a. McDonald Observatory

The description of data tapes received from McDonald Observatory during this six-month period are as follows:

Tape I.D.	Lunation	Photons	Normal Points	<N>
MCD118	1978L 8	181	21	8.6
119	1978L 9	45	3	15.0
120	1978L10	349	29	12.0
121	1978L11	303	29	10.5
122	1978L12	175	22	8.0
123	1979L 1	24	4	6.0
124	1979L 2	121	16	7.6

As usual, monthly distributions of filtered normal point data for the months July through December 1978 were made as requested. A more complete statistical summary of McDonald Observatory lunar laser ranging observations for the period July-December, 1978 can be found in University of Texas at Austin Research Memorandum in Astronomy (79-002:1979 April) entitled "Lunar Laser Ranging Data Deposited in the National Space Science Data Center: Normal Points, Filtered Observations, and Unfiltered Photon Detections for 1 July through 31 December 1978".

b. Haleakala Observatory

There were no lunar laser ranging data tapes received at Austin from Haleakala Observatory on Maui during this semi-annual report period.

c. Orroral Valley

Communications with the Division of National Mapping's Orroral Valley lunar laser ranging station in Australia through the General Electric Mark III network continued throughout this period. Data transmissions on ranging operations for about 30 individual days were received and processed. Unmistakable evidence that photon returns from the moon have been received at this station has been confirmed by our data filtering system. Statistically significant groupings of data have been identified for the dates MJD = 3801, 3803, 3833, 3834, 3848 and 3860. Upon the request of Dr. Peter J. Morgan, the points tentatively identified as signal returns from the moon as observed by the Orroral station were transmitted to the BIH for inclusion in the regular EROLD analysis. Effort is being continued to identify additional lunar returns after the 3860 date.

d. NSSDC Deposit

A deposition of McDonald Observatory lunar laser ranging data into the National Space Science Data Center at Goddard Space Flight Center in Greenbelt, Maryland was made in October, 1978. The contents of that deposit contained normal points, filtered shot-by-shot observations, and unfiltered photon detections for the time span 1 October 1977 through 31 June 1978. It should be noted that previous deposits in this series were made semi-annually on or about 1 January and 1 July and consisted of 6 month blocks of data which ended 3 months before the deposit date (i.e., April-September or October-March). Future deposits will be made on or about 1 April and 1 October and will also consist of 6 month blocks of data which end 3 months before the deposit date (i.e., January-June or July-December). The deposit referred to here is a transitional one. The next scheduled NSSDC deposit is April, 1979 and will consist of McDonald Observatory lunar laser ranging data for the period July-December, 1979.

e. EROLD Campaign

As per agreement with the Bureau Internationale de l'Heure in Paris and the EROLD Steering Committee, McDonald Observatory lunar laser ranging data to the Apollo 15 retro-reflector have been received, filtered, compressed and transmitted (via the General Electric Mark III network) from Austin to Paris for the extraction of Earth rotation information from that data. As per a revised agreement, these transmissions are being made, for McDonald data, lunation by lunation instead of week by week (as per the original agreement) since only one station data is being regularly received at this time. We have operated on the weekly schedule for more than a year with the McDonald data and have shown that schedule to be workable; the lunation-by-lunation schedule eases unnecessary pressures on our entire system. However, when multi-station data becomes regularly available, the weekly schedule will be resumed. EROLD data transfers for this semi-annual report period have been as follows:

Tape I.D.	Date Span	Normal Pts.	Transfer Date
118	8/11- 8/28/78	18	9/12/78
119	9/14- 9/14	2	10/ 6
120	10/10-10/20	20	11/10
121	11/ 8-11/21	18	12/ 4
122	12/ 6-12/20	16	1/ 5/79
123	1/ 5- 1/22/79	6	2/12

As has already been mentioned above in section I.c., several Orroral Valley lunar laser ranging data sets were also transmitted to the BIH for inclusion in the EROLD campaign activities.

II. Miscellaneous Tasks

a. Earth Rotation

Extensive efforts have been applied during this report period to prepare for the eventual multi-station lunar laser ranging data and its subsequent use for the regular extraction of Earth rotation and polar motion parameters. To this end, new routines have been designed, coded and implemented to allow the user to perform the analysis of lunar laser ranging data with respect to IPMS values of the polar motion in addition to those of the BIH (another such routine is presently in preparation to allow the user to apply LAGEOS-derived polar motion parameters as supplied by D. E. Smith at GSFC). As yet only token intercomparisons have been made among the various systems.

b. Lunar Ephemeris and Librations

In anticipation of the demise of the JPL supplied LURE-2 lunar ephemeris and LLB-5 numerically integrated lunar libration angles on JD = 2444000.5 (the numerically integrated lunar libration partial derivatives have not been available at Austin for more than a year now) a concerted effort has been made to reactivate the Eckhardt Series 400 semi-analytical expansions for lunar libration angles and partial derivatives (at the same time, the Eckhardt Series 500 expansions have also been activated as well). Also, as a stop-gap measure, to eliminate the possibility of ceasing regular filtering and normal point formation activities, the JPL DE-96 lunar ephemeris was implemented until the time a more definitive lunar ephemeris is supplied by JPL. The DE-96 ephemeris is in Tchebycheff polynomial form and it was necessary to implement new tape reading routines in addition to the normal Type 50 read package. Each of these changes to the normal "LURE-2" model seems to have been successful and no difficulties are foreseen for the Austin filtering and normal point formation activities when the "LURE-2" model expires during the next quarter. Cooperation with J. D. Mulholland and O. Calame continues with their efforts to compute numerically integrated solar system ephemerides which are independent of the MIT and JPL efforts.

c. McDonald Statistical Efficiency Parameters

Additional work has been performed on the project to correlate McDonald lunar laser ranging observations with the theoretical efficiency of lunar ranging as a function of: a.) lunar distance; b.) reflector-Sun angle; c.) reflector- telescope angle; and d.) atmospheric seeing. The soft-ware to compute the theoretical efficiency was satisfactorily completed and debugged. Several graphs were prepared to illustrate the variation of observational efficiency with the various parameters mentioned above separately and in combination. Initial results show that a variation by as much as a factor of three or more can exist in the theoretical observational efficiency. Yet to be accomplished is the correlation of actual lunar laser ranging observations with the computed efficiencies.

d. Orroral Valley Interaction

During this report period we have begun transmitting JPL-produced lunar laser ranging predictions for the Orroral Valley station from Austin to Orroral via the General Electric Mark III system. In this mode a card copy of these predictions are mailed from JPL to the University of Texas at Austin whereat they can be loaded on the Mark III system and be made available immediately to the Australian effort. In the past, great difficulties had been encountered in the mail service between the U.S. and Australia. At times mail delays have necessitated oral transmission of predictions by telephone between JPL and Orroral. We anticipate that this more efficient mode of data transmittal will eliminate such problems in the future.

One of the more exciting and important events taking place during this report period was the unmistakable evidence of lunar returns detected at the Australian lunar laser ranging station at Orroral Valley. As of 29 February 1979, some nine sets of lunar returns, comprising a total of 76 photons, during the period 10 October-19 December 1978, have been tentatively identified. Upon the request of Dr. P. J. Morgan, station director at Orroral, these data were transmitted to the BIH for EROLD purposes.

In a cooperative effort with Dr. P. J. Morgan we have begun to analyze these Australian observations with the McDonald Observatory data set in an attempt to derive a tentative McDonald Observatory-Orroral Valley baseline. Due to the great inhomogeneity of the two data sets (the McDonald set is comprised of some 2500 normal points which represent about 25,000 individual filtered photon returns for a time span of more than 9 years having an RMS accuracy of 5-15 cm while that of Orroral (described in the above paragraph) has an RMS accuracy of 50-150 cm) and because only tenatative electronic, geometric, atmospheric, and timing corrections have been applied, only a very preliminary baseline can, at this time, be computed. The value of a typical baseline obtained was 11,039,463.6 m which compares very favorably (within several meters) with that obtained for a similar Doppler-derived baseline (a McDonald-Orroral baseline has been obtained by Doppler techniques and tentative ties have been established by surveying methods to the two lunar laser ranging sites). A report on these preliminary results was presented by Shelus at the winter meeting of the American Astronomical Society Division on Dynamical Astronomy meeting held at Stanford University 27 February-3 March 1979. Also an abstract for an oral presentation of a similar paper has been submitted for the Spring AGU meeting to be held in Washington, D.C. 28 May-1 June 1979.

III. Travel

During this report period, Shelus attended the 9th GEOP Conference which was held at Ohio State University in Columbus, Ohio 2-5 October, 1978. He also attended the lunar laser ranging M/OWG meeting held at NASA Headquarters in Washington, D.C. 29-30 October 1978 followed by the LAGEOS pre-proposal briefing held at Goddard Space Flight Center 1 November 1978. Finally, as mentioned above, Shelus also attented the American Astronomical Society Division on Dynamical Astronomy meeting at Stanford University 27 February- 3

March 1979 for the presentation of a paper on a tentaive McDonald Observatory-Orroral Vally baseline.

IV. Publications

There were no publications rerlated to this grant submitted to the scientific literature during this six-month report period. However, two abstracts, each entitled "A Preliminary Orroral Valley-McDonald Observatory Baseline as Determined by Lunar Laser Ranging Observations" authored by Shelus, Morgan, and Mulholland were submitted to the AAS-DDA and to the AGU. An abstract entitled "First Results from Lunar Laser Ranging in Australia" by Cochran, Morgan, and Shelus was submitted for presentation at the May meeting of the Australian Astronomical Society. Also a document entitled "Lunar Laser Ranging Data Deposited in the National Space Science Data Center: Normal Points, Filtered Observations, and Unfiltered Photon Detections for 1 July 1978 through 31 December 1978" accompanied the regular semi-annual deposit of McDonald Observatory lunar laser ranging data into the NSSDC.

V. Staff

During this report period the project staff consisted of P. J. Shelus (Project Director) 4 mm.; R. L. Ricklefs (Systems Programmer) 3 mm.; R. I. Abbot and C. J. Stephens (Research Assistants) 3 mm. each; C. J. Campbell (Clerk-Typist) 3 mm.; J. D. Mulholland (Research Scientist) 1 mm.